28 February 1964

RESEARCH OBJECTIVE

PHASE II DEVELOPMENT OF AN EXPERIMENTAL DIRECT (VIRTUAL) IMAGE VIEWER

1. INTRODUCTION.

These objectives are a follow-on to the Phase I feasibility study and experiments carried out by [redacted] which culminated in 25X1A their proposal for an experimental engineering model.

Their study proved that, in virtual image viewing, the concept of crossed diffraction gratings generating multiple exit pupils was a method of circumventing limitations of low magnifications imposed by geometric optical laws. The theoretical maximum in such optics is 5X magnification.

It is obvious that within the next generation of viewers, the limits of exploiting photographic images with rear projection viewers will have been reached. This is based on the presumption that the best possible manufacturer is under contract and is designing the state-of-the-art of components into the latest rear projection viewers.

The logical alternative is to consider a system of viewing which bypasses the most deteriorating element of the rear projection system -- the screen -- and which forms the image of the object (in this case, the photographic image itself) directly on the retina of the human eye.

It has been suggested that such a system could be based upon the principles of viewing in the microscope. Geometrical optical laws, however, would restrict the format to micro-areas when achieving the high magnification desired.

2. CONCEPT.

The concept of crossed diffraction gratings forming the number of exit pupils necessary to circumvent the restrictions introduced by paragraph 1 was proven feasible. It is now incumbent upon the Development Branch to continue with a development program.

2.1. Purpose. This development will provide a viewing instrument which exceeds the quality of the very best rear projection screening viewer by more than just a significant factor and should at least approach and possibly equal the quality of the best scientific microscopes. It should not encumber the user with the fatigue factors associated with the microscope. It would have a similar viewing environment as the current rear projection screening viewer.

2.2. Scope. This instrument will entail research and/or development in two specific areas: optics, which includes condenser system, projection lenses and the field lens; and diffraction gratings.

2.2.1. Optics. A designed optical system will be required.

2.2.1.1. Condenser System. The condenser system will be designed and manufactured to be suitable for each selected magnification.

2.2.1.2. Projection Lens. The projection lens can, in all probability, be procured as a shelf item. The best possible should be selected for each specified magnification. If suitable lenses cannot be found, they will have to be designed and manufactured.

2.2.1.3. Field Lens. The field lens system will have to be designed and manufactured.

2.2.2. Diffraction Gratings. This item will require research and development by an organization of the highest competence.

3. GENERAL DESCRIPTION.

The engineering experimental model should be simple, without embellishments, but the critical elements, i.e., light source and its environment, custom condenser system for each selected magnification, film platen, projection lens, field lens system, diffraction gratings and the basic chassis should be of the best design and of the highest quality.

4. REQUIREMENTS.

4.1. Light Source. The light source will have a narrow band width, preferably in the 450-550 m region.

4.2. Intensity of Light. This should be of such intensity (variable) so that a density difference of 0.05 (desirable density difference 0.02) can be visually discriminated over a density range of 0 to 2.5.

4.3. Condenser System. The condenser system should be individually designed for each projection lens (magnification) or by manipulating changeable elements to achieve the same high quality of illumination as would be accomplished by individual condenser systems.

4.4. Film Platen. The film platen shall be of high quality flats, free of imperfections and particularly striations.

4.5. Film Temperature. The temperature shall not exceed ambient (75°F) by more than 20°F. Forced air cooling will be provided if necessary.

4.6. Projection Lenses. The lenses shall be of the highest quality available. If possible, they initially should be selected commercially. It is recognized that designed lenses would take advantage of the narrow band width of illumination and have the appropriate conjugate foci for the instrument. It may be necessary also to change the lens element spacing if it would add to the efficiency of the lens by accommodating the conjugate foci of the instrument. Only after adequate research and evaluation of off-the-shelf projection lenses will the technical monitor be consulted before a go-ahead for a lens design is permitted.

4.7. Field Lens. The field lens will be designed and manufactured to meet the requirements of the overall optical system.

4.7.1. Size of the field viewed will not be less than 8" x 10" - the lateral distance (width) will be the 10".

4.8. Chassis. A sturdy structure will be designed and constructed to mount the various elements and components of the system. This mounting will be of the quality providing the precision alignment necessary for maximum resolution rendition.

4.9. Mechanics and Electronics. Only those mechanical and electrical components that are absolutely necessary to insure smooth and efficient operation will be used. Of course, quality items will be used throughout.

4.10. Diffraction Gratings.

4.10.1. The crossed diffraction gratings will be designed and manufactured to insure even illumination over the entire field.

4.10.2. The frequency of rulings will be computed to insure adequate exit pupils to support a 50X maximum, the magnification goal for the experimental engineering model.

4.11. Format Requirements. A minimum of $2\frac{1}{4}$' square at the lowest magnification, 12X, will fill the largest dimension of the field lens.

4.12. Resolution. The ultimate goal for the viewer is to achieve 7 l/mm optical resolution with 200 l/mm low contrast material (2:1) in the film plane at the highest, 50X, magnification. The acceptable minimum will be 200 l/mm high contrast (100:1). Seven l/mm should be available to the viewer at all lower magnifications also. The Modulation Transfer Function of the finished system will be determined. 7